Texas A&M AgriLife Extension

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Incubating and Hatching Eggs

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Whether eggs come from a common chicken or an exotic bird, you must store and incubate them carefully for a successful hatch. Environmental conditions, handling, sanitation, and record keeping are all important factors when it comes to incubating and hatching eggs.

Fertile egg quality

A fertile egg is alive; each egg contains living cells that can become a viable embryo and then a chick. Eggs are fragile and a successful hatch begins with undamaged eggs that are fresh, clean, and fertile. You can produce fertile eggs yourself or obtain them elsewhere. While commercial hatcheries produce quality eggs that are highly fertile, many do not ship small quantities. If you mail order eggs, be sure to pick them up promptly from your receiving area. Hatchability will decrease if eggs are handled poorly or get too hot or too cold in transit.

If you produce the eggs on site, you must care for the breeding stock properly to ensure maximum fertility. Egg quality and embryo survival are influenced by hen and sire's:

- age
- health
- nutrition
- ratio
- genetics
- stress

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Factors that affect hatchability

Breeder	Hatchery
Breeder nutrition	Sanitation
Disease	Egg storage
Mating activity	Egg damage
Egg damage	Incubation—Management of setters and hatchers
Correct male and female body weight	Chick handling
Egg sanitation	
Egg storage	

Collecting and storing fertile eggs

Fertile eggs must be collected carefully and stored properly until they are incubated. Keeping the eggs at proper storage temperatures keeps the embryo from starting and stopping development, which increases embryo mortality. Collecting eggs frequently and storing them properly delays embryo development until you are ready to incubate them.

Egg storage reminders

- Store less than 10 days
- Maintain temperature between 55 to 65°F
- Keep relative humidity at 75 percent
- Turn eggs stored more than a week
- Handle eggs with care!

Cleaning and culling

Do not incubate eggs that are cracked, misshapen, soiled, or unusually small or large. These rarely hatch andcan potentially contaminate the good

eggs. Do not wash or wipe eggs with a damp cloth. Doing so can remove the egg's protective layer and allow disease and bacteria to enter. It can also spread bacteria from one dirty egg to others.

You can gently buff soiled eggs with fine sand paper but this can also damage the egg's protective coating. It is best to avoid incubating soiled eggs.

General care

Once you have eggs to incubate, avoid damaging or contaminating them. Wash your hands frequently to remove bacteria from your hands.

Storage time

Eggs should be set as soon after you collect them as possible. Storing eggs for at least three days helps prepare them for incubation; however, fresh and stored eggs should not be set together.

It is best to incubate eggs within 7 to 10 days of their being laid. Hatchability decreases rapidly when eggs are stored for more than 10 days. After 7 days, hatchability decreases 0.5 to 1.5 percent per day. Each day in storage adds one hour to the incubation time.

Temperature and humidity during storage

Fertile eggs should be stored between 55 and 65°F. If fertile eggs reach temperatures above 72°F, embryos will begin to develop abnormally, weaken, and die. Embryos stored below 46°F also have high embryo mortality. Room temperature is generally too warm and the refrigerator is too cold for storing fertile eggs. If you plan to store eggs in a refrigerator, adjust it to an appropriate temperature.

Fertile eggs should be stored at 70 to 80 percent relative humidity. High humidity can cause condensation to form on the eggshell. This can clog the pores on the eggshell and cause contamination the same way washing does. Clogging the pores can also suffocate the embryo.

Low humidity during storage can make the egg lose internal moisture and kill the embryo. To increase the humidity, place a pan of water in the storage room. It is the surface area of the water influences humidity, not the depth of the water. Avoid drafts; these can dry the eggs out even when humidity is within the appropriate range.

Positioning and turning eggs during storage

If you plan to store eggs for less than ten days before incubating, place them on flats with the large end up. You do not need to turn the eggs if they will be incubated within a week of being laid. You should cover the eggs with a loose material to keep them clean.

If you plan to store eggs for more than 10 days, tilt them from side to side over a 90-degree angle once or twice daily. You can do this by placing a six-inch block under one end of the flat, switching the end of the flat each day until incubation.

Incubation

An incubator is basically a box that holds eggs while maintaining an appropriate temperature, humidity, and oxygen level. Incubators have varying capacities and adapters for eggs from different species.

Popular incubator models often include automatic turners, humidifiers, and temperature controllers. Egg turners can usually be purchased separately for incubators that do not include them. Humidifiers can be the type that disperses water vapor as needed or many smaller incubators use a simple water reservoir. Temperature is controlled by older wafer systems or the newer digital thermostats.

Incubators come in forced air or still air versions. The temperature and humidity in a forced air incubator is more consistent. They also return to desired temperature and humidity more quickly after being opened.

Still air incubators can give inaccurate humidity and temperature readings and the temperature in them can vary considerably. Whenever possible, use a forced air incubator. Regardless of incubator type, for a successful hatch you must turn the

eggs and monitor the temperature, humidity, and ventilation.

The incubator should be in a room that has no drafts or direct sunlight; the temperature and humidity should be controlled and stable. The incubator and hatcher should also be isolated from the growing facilities. Newly hatched chicks can be contaminated by older birds and the dust created by growing birds. Take biosecurity measures to insure the incubator area is not contaminated by older birds.

Chicks may be hatched in the incubator depending on what type it is; however, hatching creates large amounts of dust and down. Hatching in a separate unit will keep dust and down from contaminating the incubator. Temperature and humidity can also be controlled more easily if you use separate units for incubating and hatching. Regardless of method, you must properly clean and disinfect the incubator and hatcher between batches.

Two to three days before incubation

Sanitize the incubator and run it for several days before setting the eggs. This will ensure that the incubator is maintaining the proper temperature and relative humidity before the eggs are set. Adjusting the temperature and humidity after the eggs are set can decrease hatchability. If you are using an automatic turner, test it completely before setting the eggs. The temperature and humidity of the incubation room should be correct and stable when you set the eggs. Do not set the eggs until the temperature and humidity in the incubators and the room are correct and stable.

Cleaning and fumigation

Microbes in an incubator can significantly reduce hatchability. Cleaning and disinfecting equipment must be standard operating procedures. Disinfect, incubators, hatchers and their racks with quaternary ammonia or a commercial disinfectant after each hatch.

The day eggs are set

Let stored eggs warm to room temperature for 4 hours to 8 hours before setting them in the incubator. If you place cold eggs in a warm, humid incubator, condensation will form on them and lead to possible contamination or suffocation.

Once the eggs are in the incubator, do not adjust the temperature or humidity for a few hours, unless the temperature exceeds 102°F. After 4 hours, make proper adjustments. The final temperature should vary only .5 degree above or below 99.5°F. The temperature of incubators without circulating fans fluctuates more than incubators with circulating fans. If the temperature does not exceed 102°F, the hatch should not be harmed.

Set the small end of the egg lower than the large end in the incubator. A developing embryo orients so that the head develops toward the air cell, which is in the large end of the egg. If the small end is higher than the large end during incubation, a chick's head can orient away from the air cell of the egg and not hatch.

Set stage

The set stage refers to incubation period up until 2 or 3 days before a hatch. Different species have different incubation periods (Table 1). Incubating different species together in the same incubator is not recommended, especially if the incubator is also used as hatcher.

Turning the eggs during incubation prevents embryo death and unhealthy hatches. Eggs must be turned at least five times every 24 hours. Turning more frequently is better and once per hour is best. Keep accurate records to ensure the eggs are turned three to five times each 24-hour period. Failure to turn eggs appropriately results in embryo death.

Turning must continue even through weekends. An automatic turner simplifies this task and decreases human error during the incubation process.

Table 1. Incubation period to hatch time and when to transfer to hatcher. Temperature and humidity levels for common birds.

Common name	Incubation conditions			Hatcher conditions		
	Days	Temperature °F	Humidity %RH	Transfer day	Temperature °F	Humidity
canary	13–14	100.5	56–58	11	99	66–74
chicken	21	99.5	58	18	98.5	66–75
cockatiel	18–20	99.5	58–62	15–18	99	66–74
cockatoo	22–30	99.5	58–62	20–27	99	66–74
conure (sun)	28	99.5	58–62	25	99	66–74
conure (various)	21–30	99.5	58–62	18–27	99	66–74
dove	14	99.5	58	12	98.5	66–75
duck	28	99.5	58–62	25	98.5	66–75
muscovy duck	35–37	99.5	58–62	31–33	98.5	66–75
finch	14	99.5	58–62	12	99	66–74
Domestic goose	30	99.5	62	27	98.5	66–75
geese (various)	22–30	99.5	62	20–27	98.5	66–75
grouse	24–25	99.5	54–58	22	99	66–74
guinea	28	99.5	54–58	22	99	66–74
lovebird	22–25	99.5	58–62	20–22	99	66–74
macaw	26–28	99.5	58–62	23–25	99	66–74
mynah	14	100.5	56–58	12	99	66–74
parakeet	18–26	99.5	58–62	15–23	99	66–74
budgerigar	18	99.5	58–62	15	99	66–74
parrot (various)	18–28	99.5	58–62	15–25	99	66–74
parrot (african grey)	28	99.5	58–62	25	99	66–74
chukar partridge	23–24	99.5	62	20	99	66–74
peafowl	28–29	99.5	58–62	25–26	98.5	66–75
ptarmigan	21–23	99.5	58–62	18–20	99	66–74
raven	20–21	99.5	58–62	17–18	99	66–74
ring-neck pheasant	24–24	99.5	58–62	21	99	66–74
pheasant	22–28	99.5	58–62	20–25	99	66–74
pigeon	17–19	100.5	58	14	99	66–74
bobwhite quail	23	99.5	54–58	21	99	66–74
japanese quail	17–18	99.5	58–62	15	99	66–74
swan	33–37	99.5	58–62	30–33	99	66–74
turkey	28	99.5	54–58	25	98.5	66–75
emu	49–50	97.5	32–40	47	97.5	69
ostrich	42	97.5	32–40	39	97.5	69
rhea	36–42	97.5	50	34–37	97.5	69

Temperature, humidity, and ventilation of incubator

During the set stage, temperature in the incubator should be 99.5°F to 100°F for chickens. Other species have different requirements (Table 1). If the temperature deviates more than ½ degree from 100°F, a poor hatch is likely. Check the temperature at least twice a day.

Relative humidity should be set at 55 to 60 percent. If the incubator uses a passive humidity control system, add water to the pan or trough daily to maintain correct humidity levels. If the humidity in the incubator is too low or too high, the hatch will fail.

Insufficient humidity causes:

- The air cell to be too large at the time of hatch
- The contents of the egg be too viscous for the chick to turn
- The membranes to be too tough to break
- The navel to not close properly

Excess humidity will cause:

- Too little water to evaporate from the egg
- The air cell to be too small for the chick to reach during the hatching process
- The chick to drown or be too swollen with water to turn in the egg
- The yolk sac to be too large for the navel to close completely

The air cell of the egg should become larger as incubation progresses because of the balance between temperature and humidity during incubation. Chicken eggs lose 12 percent to 14 percent of their total weight to evaporation during incubation. You can weigh racks of eggs during incubation to detect problems with humidity and evaporative loss before a hatch is destroyed.

The chick embryo uses oxygen and produces carbon dioxide. This gas exchange is insignificant during early incubation or when a small number of eggs are incubated; however, follow the manufacturer's recommendations to assure that developing chicks have adequate oxygen available. Near the end of the incubation period, the shell nearly filled with the embryo and a full incubator requires large amounts of oxygen. Ensure adequate ventilation and monitor wet and dry bulb temperatures very carefully during the last third of incubation.

Incubation Reminders

- Place the incubator in a room with a constant temperature, no drafts or direct sunlight.
- Sanitize the incubator.
- Wash hands before touching eggs. Keep germs, dirt and oil away from incubating eggs.
- Only incubate eggs together from species with similar incubation periods.
- Keep the small end of the egg lower than the large end.
- Record of incubator data daily.
- Ensure that the humidifier is working or that the water pan is filled.
- Verify humidity levels are between 55 to 60 percent.
- Check temperature daily and keep it at 99.5°F to 100°F.
- Turn eggs at least 5 times a day until 3 days before hatch.
- Increase ventilation during the last third of incubation.
- Do not turn for the final 3 days. Provide a cloth or rough paper for the chicks to walk on.
- Increase humidity to 65 to 70 percent at hatch stage.

Record keeping

Record the incubator environment daily (Appendix A). The sample record on page 11 is designed for use with eggs that hatch after 21 days of incubation. You can use records of your hatches to detect malfunctions before a hatch is ruined. Records of fertility and embryo deaths can also alert hatchery managers about problems with production, storage, or incubators.

Candling

Shining a light through the egg to observe embryo development is called candling. White or pale eggs are easier to candle than dark or speckled eggs. Many people candle eggs with a small flashlight that can be focused. You can also buy commercial candlers at reasonable cost.

In a dark room, hold the egg to the light of the candler to observe the contents of the egg. Cooling that occurs for less than 10 minutes during candling does not harm the embryo. However, even a brief period at 104°F kills embryos—expose the egg to the hot light sources only briefly.

Embryos can be confirmed easily after 8 to 12 days of incubation. The living embryo will appear as a dark spot in the large end of the egg surrounded by a faint outline of blood vessels. The blood vessels will appear firm and distinct. The embryo appears as dark spot that becomes larger as incubation progresses. Eventually you will see only a dark mass and the air cell.

In comparison, an infertile or unincubated egg transmits light brightly. Dead embryos will sometimes appear as a ring or a smear of blood in the egg or a dark spot dried to the inside of the shell. Once it dies, the embryo no longer grows and the blood system fades.

You should expect some mortality; however, unusual mortality or certain characteristics of the mortality can be indicators that you need to correct certain practices to improve hatchability.

Keep records of egg infertility or embryo death for reference.

Ten percent or more of incubated eggs are infertile. Identifying and removing eggs that are infertile or dead eliminates possible sources of contamination from the incubator. If you have doubts about candling, seek expert advice.

Hatch stage

This stage refers to final 2 to 3 days of incubation when chicks hatch out of the shell. Transfer eggs to a dedicated hatcher for the last 3 days to 4 days of incubation and do not turn them. If a hatcher is not available, remove the eggs from the turner and lay them in the hatching basket or place them on cloth or rough paper (not newspaper) in the incubator. Make sure the cloth or paper do not cover vent holes, or touch the water or the heating element.

During this stage, decrease the temperature 1°F and increase the relative humidity to 65 to 70 percent. You can increase the humidity by adding a wet sponge or wet paper towels to the incubator. The chicks should start to pip within a day of the incubation period listed for the species in Table 1.

Table 2. Incubating and hatching egg and chick classification

Culled eggs	Cracked, misshapen or otherwise not likely to hatch
Infertile eggs	Determined to have no germ. Originally infertile. These eggs are clear during candling and show no evidence of blood or embryo development.
Early dead	Embryos died during the first quarter of incubation. Some of these can be detected and removed during candling. These eggs would be fertile and could show a dead early embryo, show no development, development but no blood, or a blood ring.
Middle dead	Embryos died after the early (middle third) period but before transfer.
Late dead	Embryos died during the hatch phase of incubation.
Malformed	Embryos that have an obvious deformity.
Malpositioned	Embryos not positioned correctly for hatching.
Live pips	Chicks that have pipped and are living, but not hatched.
Dead pips	Pipped chicks that died but are not malformed or malpositioned.
Rots	Infected or contaminated eggs.
Culled chicks	Chicks that hatched but are unsound.
Good chicks	Good quality, healthy normal chicks.

When chicks hatch

Hatching requires great effort; the chick is very active then takes long rests. The entire process takes 10 hours to 20 hours. Do not worry about how long a chick takes to hatch unless it takes more than 20 hours.

Eggs that are not hatched 1 day after the predicted incubation period should be discarded. Do not help a chick free itself from the shell; chicks that cannot hatch on their own usually die. If you help them and they live, they usually will not thrive. Dispose of weaker deformed chicks humanely. These chicks should never be used for breeding because these traits could be transmitted to their young.

Once chicks successfully leave the shell, increase the ventilation in the incubator and leave them in it about 24 hours or until their feathers are dry.

Table 3. Possible causes of hatching problems

Observation	Possible cause(s)
Eggs exploding	Dirty eggs Improperly cleaned eggs Dirty incubator
No embryonic development	Infertile egg Rough handling of eggs Incubation temperature too high Incubation temperature too low Eggs stored too long Eggs stored improperly Breeders stressed Too many hens per rooster Old or unhealthy hens or males Inbreeding Disease
Blood ring Early dead	Old eggs Incubation temperature too high Incubation temperature too low Electric power failure Eggs not turned Inbreeding Infection Poor nutrition of breeders
Air cell too small	Humidity too high
Air cell too large	Humidity too low
Chicks hatch early, dry chicks, bloody navels, chicks too small	Small eggs Temperature too high Humidity too low
Chicks hatch late	Large eggs Old eggs Temperature too low Humidity too high
Chicks dead after pipping	Eggs not turned first 2 weeks Thin-shelled eggs Temperature too low during incubation Temperature too high during incubation Humidity too low during incubation Humidity too high during incubation Infection, disease
Unhealed navel Mushy chicks	Temperature too low during incubation Wide temperature variation in incubator Humidity too high during incubation Poor ventilation
Malformed legs and toes	Improper temperature during incubation Improper humidity during incubation Legs also may be harmed by hatching or holding chicks
Weak chicks	Temperature too high or low Old eggs Poor ventilation
Gasping chicks	Disease: Bronchitis or Newcastle disease
Malpositions	Temperature too high or low Turning inadequate Large end of egg not up when set Old or poorly handled eggs Poor breeder nutrition

When more than 90 percent of the chicks are dry, remove them from the hatcher. Move the chicks to a warm brooder and give them water and feed. Leaving chicks in the incubator too long can dehydrate them.

Embryo death

Eggs fail to hatch because they are infertile or because the embryo dies. You can candle eggs during incubation or examine them after the hatch to determine what caused them to fail. Humidity control can sometimes contribute to these problems.

Embryos usually die during the first 3 days of incubation or the 3 days immediately before a hatch. Early embryo death happens when embryonic organs are forming. However, eggs that are fertile one third of the way through incubation have an 88 to 90 percent chance of continuing to develop.

Death at the end of the incubation process can occur because the chick:

- Has difficulty positioning for pipping
- Cannot absorbing the yolk sac
- Cannot transition to breathing air

Record when embryos die to identify changes you need to make in the incubation process. A sample record form for hatch and fertility failures is in Appendix A.

Examine the eggs that fail to hatch by removing the top of the egg at the large end. A chick that has developed appropriately in the egg will normally have its head under the right wing. The air cell will be large enough to allow the chick to position correctly for hatching. The shell membranes should not dry to the chick during hatch. Note any dryness. Note the condition of the beak, wings, and legs for proper form.

Carefully classify infertile or dead embryos using the designations listed in Table 2. All abnormalities should be recorded and analyzed to determine if hatch failure was caused by fertility or environmental problems that can be corrected.

Use the Hatchability and Mortality Record (Appendix B) to calculate the percentage fertility, percentage hatchability, and percentage of total eggs hatched. These numbers will help in evaluating hatch efficiency. Any changes in the mortality records data are early warnings to correct small problems before they become serious.

Nutrition can be a factor in fertility and hatchability problems, as recognized by the National Research Council (Appendix C).

Resources

Professional advice and support

The office of the Texas AgriLife Extension Service in your county listed in the telephone directory under the county name.

Gregory S. Archer
MS 2472 TAMU
College Station, TX 77843-2472
Telephone: (979) 845-4319
E-mail: garcher@poultry.tamu.edu

PowerPoint presentation: An accompanying slideshow is available at your local Extension office or the Texas A&M Department of Poultry Science.

Sources of fertile eggs

There are many sources for fertile eggs. Some sources are convenient and the eggs affordable, but egg quality and fertility can be a problem.

One source of fertile eggs is Texas A&M University, which will ship as few as 2 dozen fertile eggs. Prices and other information are subject to change.

To order fertile eggs from Texas A&M, please complete and submit the form at http://posc.tamu.edu/fertile-egg-orders

Or contact Dale Hyatt at (979) 845-4367

No credit cards are accepted. Eggs are sold in dozen and half dozen quantities only, with a minimum 2 dozen order. Eggs are $7 per dozen plus a $3 handling fee per order, plus shipping.

Shipping within Texas: Eggs are shipped via Greyhound Bus Lines to the nearest bus terminal.

Please check with Greyhound for shipping times between Bryan, Texas and your destination. Shipping charges vary according to the number of eggs ordered and the distance from shipping point.

When ordering, request fertile chicken eggs for a school project. You will be billed at the **end of the month.**

Sources of fertile eggs, incubators, and equipment

Cackle Hatchery
PO Box 529
Lebanon, MO 65536
(417) 532-4581
cacklehatchery.com

Carolina Biological Supply Company
P.O. Box 6010
Burlington, NC 27216
(800) 334-5551
www.carolina.com

GQF Manufacturing Co.
2343 Louisville Rd.
Savannah, GA 31415-1619
(912) 236-0651
www.gqfmfg.com

Hoffman Hatchery Inc.
P.O. Box 129
Gratz, PA 17030
(717) 365-3694
www.hoffmanhatchery.com

Ideal Poultry
PO Box 591
Cameron, TX 76520
(254) 679-6677
www.ideal-poultry.com

Kemp's Incubators
3560 West 18th Ave.
Eugene, OR 97402
(888) 901-2743
www.poultrysupply.com

Lyon Technologies, Inc.
1690 Brandywine Avenue
Chula Vista, CA 91911
(888) 5966-872
www.lyonusa.com

McMurray Hatchery
P.O. Box 458
191 Closz Drive
Webster City, Iowa 50595
(800) 454-3280
www.mcmurrayhatchery.com

Meyer Hatchery
626 State Route 89
Polk, OH 44866
(888) 568-9755
www.meyerhatchery.com

Randall Burkey Co., Inc.
117 Industrial Dr.
Boerne, TX 78006
(800) 531-1097
www.randallburkey.com

Stromberg's Chicks and Game Birds
P.O. Box 400
Pine River, MN 56474
(800) 720-1134
www.strombergschickens.com

Ridgway Hatcheries, Inc.
615 North High St. Box 306
Larue, OH 43332
(740) 499-2163
ridgwayhatchery.com

Welp Hatchery
P.O. BOX 77
Bancroft, Iowa 50517
(800) 458-4473
www.welphatchery.com

Helpful books

Bird, Egg, Feather, Nest, by Maryjol Koch. Smithmark Publishing, 1999.

Chicken and Egg, by Christine Back, and Olesen Jens. A&C Black Publishers Ltd, 1992.

Chicks & Chickens, by Gail Gibbons. Holiday House, 2005.

Eggs and Chicks, by Fiona Patchett. Usborne Books, 2007.

Eyewitness Books: Bird, by David Burnie. DK Children., 2008.

From Egg to Chicken, by Anita Ganeri. Heineman-Raintree, 2006.

From Egg to Chicken, by Gerald Legg. Children's Press, 1998.

From Egg to Chicken, by Robin Nelson. Lerner Publications, 2003.

See How They Grow: Chick, by Jane Burton. DK Preschool, 2007.

The Chicken or the Egg?, by Allan Fowler. Children's Press, 1993.

Where Do Chicks Come From?, by Amy Sklansky. Collins, 2005.

Websites

http://www.enchantedlearning.com/subjects/birds/info/chicken/egg.shtml

http://chickscope.beckman.uiuc.edu/resources/egg_to_chick/development.html

www.4-h.org/Resource-Library/.../Emb-Help-Guide-Beginner.dwn

www.4-h.org/Resource-Library/.../Emb-Help-Guide-Advanced.dwn

Wall charts

Chicken Development, Chart by Carolina http://www.carolina.com/

Chicken Development, Poster by Ward's Natural Science http://wardsci.com/

Chicken Embryo, by American Educational Products, LLC http://www.amep.com/

Chicken Embryology, Poster Set" by eNasco http://www.enasco.com/

Technical references

A Guide to Better Hatching, by Janet Stromberg. Stromberg Publishing Company, 1975.

Hatching Manual, Lyon Electric Company, Inc. 1988.

Practical Incubation, by Rob Harvey. Hancock House Publishers, 1993.

http://www.cobb-vantress.com/products/guide-library/general/hatchery-management-guide

Appendix A: Incubator Data Chart

Day#	Date	Turner Works[1]			Temperature		Wet Bulb	Water Checked	Candling	Remarks
		1	2	3	Room	Incubator				
1										
2										
3										
4										
5										
6										
7										
8										
9										
10										
11										
12										
13										
14										
15										
16										
17										
18										
19		xxx	xxx	xxx						
20		xxx	xxx	xxx						
21		xxx	xxx	xxx						

This record is important. Keeping data will help prevent problems from developing during incubation.
[1]Check the turner three times each day except days 19 through 21. Eggs are not turned on these days.

Appendix B: Hatchability and mortality record

ID #	Set date	Candling date	Eggs		Dead			Malformed/ Malposition	Pips Live/Dead	Rots	Chicks		Percentage		
			Culled	Infertile	Early	Middle	Late				Cull	Good	Fertility[1]	Hatch[2]	Total[3]
								/	/						
								/	/						
								/	/						
								/	/						
								/	/						
								/	/						
								/	/						
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								/	/						
								/	/						
								/	/						
								/	/						

This record is important. Keeping data will help identify problems with bird husbandry and incubation.

[1]Fertility (%) = (Fertile Eggs/Eggs Set) x 100%

[2]Hatchability (%) = (Good Chicks Hatched/Fertile Eggs) x 100%

[3]Total Eggs Hatched (%) = (Good Chicks Hatched/Eggs Set) x 100%

Appendix C: Signs of deficiency in the embryo

Nutrient	Deficiency signs
Vitamin A	Death at about 48 hours of incubation from failure to develop the circulatory system; abnormalities of kidneys, eyes and skeleton.
Vitamin D	Death at about 18 or 19 days of incubation, with malpositions, soft bones, and with a defective upper mandible prominent.
Vitamin E	Early death at about 84 to 96 hours of incubation, with hemorrhaging and circulatory failure (implicated with selenium).
Vitamin K	No physical deformities from a simple deficiency, nor can they be provoked by antivitamins, but mortality occurs between 18 days and hatching, with variable hemorrhaging.
Thiamin	High embryonic mortality during emergence but no obvious symptoms other than polyneuritis in those that survive.
Riboflavin (Vitamin B_2)	Mortality peaks at 60 hours, 14 days, and 20 days of incubation, with peaks prominent early as deficiency becomes severe. Altered limb and mandible development, dwarfism and clubbing of down are defects expressed by embryo.
Niacin	Embryo readily synthesizes sufficient niacin from tryptophan. Various bone and beak malformations occur when certain antagonists are administered during incubation.
Biotin	High death rate at 19 days to 21 days of incubation, parrot beak, chondrodystrophy, several skeletal deformities and webbing between the toes. Perosis.
Pantothenic acid	Deaths appear around 14 days of incubation, although marginal levels may delay problems until emergence. Variable subcutaneous hemorrhaging and edema; wirey down in poults.
Pyridoxine	Early embryonic mortality based on antivitamin use.
Folic acid	Mortality at about 20 days of incubation. The dead generally appear normal, but may have bent tibiotarsus, syndactyly and mandible malformations. In poults, mortality at 26 days to 28 days of incubation with abnormalities of extremities and circulatory system.
Vitamin B_{12}	Mortality at about 20 days of incubation, with atrophy of legs, edema, hemorrhaging, fatty organs, and head between thighs malposition.
Manganese	Deaths peak prior to emergence. Chondrodystrophy, dwarfism, long bone shortening, head malformations, edema, and abnormal feathering are prominent. Perosis.
Zinc	Deaths prior to emergence, and the appearance of rumplessness, depletion of vertebral column, eyes underdeveloped and limbs missing.
Copper	Deaths at early blood stage with no malformations.
Iodine	Prolongation of hatching time, reduced thyroid size, and incomplete abdominal closure.
Iron	Low hematocrit; low blood hemoglobin; poor extra-embryonic circulation in candled eggs.
Selenium	High incidence of dead embryos early in incubation.

Texas A&M AgriLife Extension Service

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